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(54) **METHOD AND DEVICE FOR FACILITATING RESTRICTED PROXIMITY DISCOVERY OF AN APPLICATION USER**

(57) A proximity-based services server performs a method for facilitating restricted proximity discovery of a user of an application. The method includes obtaining authorization to access a first user's resources for a first application. The method also includes communicating a list of associates from the first user's resources and receiving an indication of a set of associates selected from the list of associates. Each associate in the set is permitted to discover the first user. The method further includes receiving a request for a proximity-based services code and allocating a first proximity-based services code to the first user for the first application. Additionally, the method includes announcing, to a set of other proximity-based services servers, existence of the first proximity-based services code allocated to the first user for the first application.

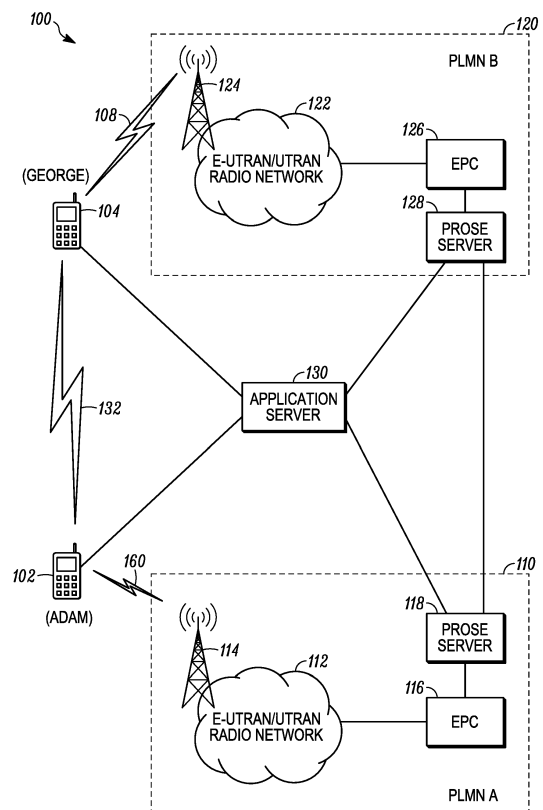


FIG. 1

Description

RELATED APPLICATIONS

[0001] The present application is related to and claims benefit under 35 U.S.C. §119(e) from U.S. Provisional Patent Application Serial No. 62/116,491, filed February 15, 2015, titled "Method and Device for Facilitating Restricted Proximity Discovery of an Application User" (attorney docket no. MM01179), the entire contents of which are incorporated herein by reference.

FIELD OF THE DISCLOSURE

[0002] The present disclosure relates generally to discovery of an application user and more particularly to a method and device for restricted discovery of a first user by selected other users who are in proximity to the first user and are associated with the first user through an application.

BACKGROUND

[0003] In the context of a Proximity-based Services (ProSe) project that has been active in a 3rd Generation Partnership Project (3GPP) Service and System Aspects (SA2) working group, there has been work to specify a ProSe solution that supports restricted discovery, also referred to herein as restricted proximity discovery. Basically, restricted discovery provides a mechanism for a second user of an application to discover a first user of the application when both users are in close proximity, but only when the first user has explicitly consented to be discoverable by the second user. Accordingly, restricted discovery enables a user to restrict the number of his friends on a social networking application, for example, who can discover him.

[0004] To support restricted discovery, some solutions have been proposed in SA2, for instance as documented in 3GPP Specification TR 23.713 v0.3.0 (2014-11), clause 5. A shortcoming of these proposed solutions is that they require changes to applications, such as Facebook, Twitter, Google+, Instagram, etc. For example, to enable Facebook restricted discovery, the application running on the Facebook servers must be modified as well as the application programming interfaces (APIs) supported by the Facebook servers. These requirements could lead to very limited or even no deployment of the proposed solutions in practice.

BRIEF DESCRIPTION OF THE FIGURES

[0005] The accompanying figures, where like reference numerals refer to identical or functionally similar elements throughout the separate views, together with the detailed description below, are incorporated in and form part of the specification, and serve to further illustrate embodiments of concepts that include the claimed

embodiments, and explain various principles and advantages of those embodiments.

FIG. 1 is a schematic diagram illustrating an environment in which at least one ProSe server and user device is configurable in accordance with some embodiments.

FIG. 2 is a message sequence diagram illustrating collaborative functionality for facilitating restricted discovery of a user of an application in accordance with an embodiment.

FIG. 3 is a message sequence diagram illustrating collaborative functionality for facilitating restricted discovery of a user of an application in accordance with another embodiment.

FIG. 4 is a block diagram illustrating internal hardware components of a user device configurable in accordance with some embodiments.

FIG. 5 is a block diagram illustrating internal hardware components of a ProSe server configurable in accordance with some embodiments.

[0006] Skilled artisans will appreciate that elements in the figures are illustrated for simplicity and clarity and have not necessarily been drawn to scale. For example, the dimensions of some of the elements in the figures may be exaggerated relative to other elements to help to improve understanding of embodiments of the present disclosure.

[0007] The apparatus and method components have been represented where appropriate by conventional symbols in the drawings, showing only those specific details that are pertinent to understanding the embodiments of the present disclosure so as not to obscure the disclosure with details that will be readily apparent to those of ordinary skill in the art having the benefit of the description herein.

DETAILED DESCRIPTION

[0008] Pursuant to the various embodiments are methods and proximity-based services servers, which can reside in one or more cellular networks, and which are configured for facilitating restricted discovery of a user of an application. For a particular embodiment that facilitates announcement of the presence of a first user, a first proximity-based services server activates proximity services for a social networking application for the first user, which includes obtaining authorization to access the first user's resources for the social networking application. The first proximity-based services server presents the first user with a list of friends from the social networking application for selecting the friends that are permitted to discover the first user. Responsive to a request from the first user, the

first proximity-based services server allocates a proximity-based services code to the first user for the social networking application, wherein a device of the first user can announce the code locally. The first proximity-based services server also announces existence of the first proximity-based services code to a set of other proximity-based services servers, which includes a second proximity-based services server.

[0009] For facilitating monitoring the presence of the first user, the second proximity-based services server activates proximity services for the social networking application for a second user. Upon receiving, from the second user, a request to monitor for the presence of the first user, the second proximity-based services server confirms that the first user is a friend of the second user on the social networking application before requesting the first proximity-based services code for the first user from the first proximity-based services server. The second proximity-based services server provides the first proximity-based services code to a device of the second user to use in monitoring for the presence of the first user by detecting the announcement by the device of the first user of the first proximity-based services code when the first and second users are in close proximity.

[0010] Disclosed embodiments do not require any changes to the application servers or the APIs supported by the application servers. Accordingly, the embodiments provide a solution for restricted discovery that can be deployed, for instance, by cellular operators and which enables the cellular operators to control the restricted discovery functionality using processes that are transparent to the application servers.

[0011] FIG. 1 illustrates a schematic diagram of an example environment 100 within which may be implemented methods and devices for facilitating restricted discovery of a user of an application, in accordance with the present teachings. As illustrated, environment 100 includes a public land mobile network (PLMN) A 110, a PLMN B 120, and an application server 130. As shown, a user Adam can operate his user device 102, in this case a wireless communication device, to establish a link 160 to wirelessly connect to PLMN A 110. Similarly, a user George can operate his user device 104 to establish a link 108 to wirelessly connect to PLMN B 120. For a particular implementation scenario, Adam is a cellular subscriber in PLMN A 110 and can, thereby, receive from PLMN A 110 services such as ProSe services, including restricted discovery services implemented in accordance with the present teachings. Similarly, George is a cellular subscriber in PLMN B 120 and can, thereby, receive from PLMN B 120 services including restricted discovery services.

[0012] Each PLMN includes an access network, e.g., 112 and 122, which can use any type of radio access technology (RAT) for a wireless communication device to access and communicate using the access network. For the embodiment shown, the access networks 112 and 122 are cellular access networks, also referred to

herein as a cellular networks, having at least one cellular tower or base station, e.g., 114 and 124, for facilitating the establishment of wireless links by user devices to the access networks.

[0013] The PLMNs A 110 and B 120 also include a core network, e.g., 116 and 126, and a ProSe server or ProSe function, e.g., 118 and 128, connected to the core network. As shown, the cellular networks 112 and 122 and the core networks 116 and 126 are implemented using 3GPP standards or specifications, for example as Long-Term Evolution (LTE) networks. More particularly, the cellular networks 112 and 122 are Evolved UMTS Terrestrial Radio Access Networks (E-UTRANs) or legacy UTRANs having at least one eNodeB, e.g., 114 and 124, for facilitating wireless links to user equipment (UE) such as wireless communication devices 102 and 104. The core networks 116 and 126 that support the cellular networks 112 and 122 are, correspondingly, System Architecture Evolution (SAE) cores, also referred to in the art as Evolved Packet Cores (EPCs). The EPC subcomponents (not shown) can include, among other subcomponents, a Mobility Management Entity (MME), a Serving Gateway (S-GW), a PDN Gateway (P-GW), a Home Subscriber Server (HSS), etc.

[0014] Although in the illustrated embodiment the cellular access networks 112 and 122 use E-UTRA as the RAT, any other cellular or cellular-based access technology can be used. Such technologies include, but not limited to: an analog access technology such as Advanced Mobile Phone System (AMPS); a digital access technology such as Code Division Multiple Access (CDMA), Time Division Multiple Access (TDMA), Global System for Mobile communication (GSM), integrated Digital Enhanced Network (iDEN), General Packet Radio Service (GPRS), Enhanced Data for GSM Evolution (EDGE), etc.; and/or a next generation access technology such as Universal Mobile Telecommunication System (UMTS), Wideband CDMA (WCDMA), IEEE 802.16, etc., or variants thereof.

[0015] Additionally, although not shown, environment 100 can further include other networks coupled to and supported by the core networks 116 and 126 and accessible to user devices 102 and 104. Such networks include, for example: the Internet; one or more packet data networks (PDNs); or one or more Wireless Local Area Networks (WLANs). The WLANs have at least one access point for facilitating wireless links using, for instance, Institute of Electrical and Electronics Engineers (IEEE) 802.11 standards, also referred to in the art as WiFi technology, or using Worldwide Interoperability for Microwave Access (WiMax) technology. A PDN can be, for instance, an enterprise network, an IP Multimedia Subsystem (IMS), etc.

[0016] The application server 130 is used to provide services to users, such as Adam and George, to become associates of one another by forming connections using an application, downloaded to a user device. The downloaded application interacts with a corresponding appli-

cation on the application server 130. For one example, the application server resides in the Internet, which is accessible by user devices 102 and 104 and ProSe servers 118 and 128 through Internet connections.

[0017] For a particular embodiment, the application server 130 is a social networking server that provides social networking services that enable a user to build and/or maintain social relationships. Particularly, the social networking service allows a user to establish a profile that contains selected personal information of the user, such as interests, education history, work history, etc., and to establish a list of associates called "friends," which can include a list of application identifiers. The list of friends is authorized to interact with the user, and at least some of the user's friends may also be authorized to view a portion of the information in the user's profile. The user accesses the social networking application using credentials that include a user identification or identifier (ID) and password. The user's information on (e.g., profile and associate list) and credentials for the application are collected referred to herein as the user's "resources." Some currently popular social networking services used worldwide include Facebook, Google+, LinkedIn, Instagram, Pinterest, Vine, Tumblr, and Twitter.

[0018] The ProSe servers 118 and 128 are configured to provide proximity-based services to users that allow users to discover one another. One type of proximity-based service is restricted ProSe discovery or restricted discovery. Restricted discovery enables users of an application and associated application services, such as a social networking application and associated social networking services, to select which other users of the application can discover them. Particular embodiments of restricted discovery are described below by reference to FIG. 2 and FIG. 3.

[0019] FIG. 2 is a message sequence diagram 200 illustrating collaborative functionality for facilitating restricted discovery of a first user (e.g., Adam) by enabling Adam to announce his presence. FIG. 3 is a message sequence diagram 300 illustrating collaborative functionality for facilitating restricted discovery of Adam by enabling a second user authorized by Adam (e.g., George) to associate Adam's announcements with Adam and to, thereby, discover Adam when Adam and George are in close proximity. Close proximity means, for instance, within wireless communication range. For one embodiment, close proximity means within range for Adam and George to use their respective devices 102 and 104 to communicate over a direct connection 132 using a wireless peer-to-peer (P2P) technology such as LTE-Direct, WiFi-Direct or Bluetooth low energy (BLE).

[0020] Diagrams 200 and 300 show messages being exchanged between two or more of the devices of: Adam's user equipment (UE) 102; the ProSe server 118 of PLMN A 110; the application server 130, which in this example is a Facebook server; George's UE 104; the ProSe server 128 of PLMN B 120; and a ProSe server 206 of PLMN C 202. The message exchanges can be in

accordance with any suitable protocol either standard or proprietary including, but not limited to, OAuth protocol, Hypertext Transfer Protocol (HTTP), Internet Protocol (IP), etc. For an embodiment, Adam and George download to their user devices a proximity-based services (ProSe) application from the operator of their respective cellular networks. The ProSe application facilitates the exchange of messages between Adam's and George's UEs and the respective ProSe servers 118 and 128 to enable restricted discovery for the Facebook application.

[0021] Let us assume for the purposes of this use case scenario that Adam and George are Facebook friends, and George desires to know when Adam is nearby, e.g., within communication range. Accordingly, Adam launches the ProSe application on his UE 102. The ProSe application makes a secure connection with the ProSe server 118 (the address of which can be preconfigured or discovered with the Domain Name System), and Adam is authenticated using a message exchange 208 between Adam's UE 102 and the ProSe server 118. Authentication and security establishment message exchange 208 enables the ProSe server 118 to confirm authorization of Adam for using proximity-based services for applications such as Facebook. After successful authentication, the ProSe server 118 knows the MSISDN and/or IMSI of UE 102, and can, therefore, charge Adam and determine if Adam is subscribed to certain proximity-based services.

[0022] Messages 210 can then be exchanged between Adam's UE 102, the ProSe server 118 and the Facebook server 130 to activate proximity-based services for Adam for Facebook. Namely, Adam uses the ProSe application to initiate a message exchange 212 between his UE 102 and the ProSe server to request proximity-based services for Facebook. For a particular example, through the ProSe application on the UE 102, Adam is presented with a page that asks, for example, whether to "Activate Discovery for Facebook". Upon Adam indicating his desire to activate restricted discovery for Facebook, for instance through clicking or activating an icon, messages 214 are exchanged between Adam's UE 102, the ProSe server 118, and the Facebook server 130 to enable the ProSe server 118 to obtain authorization to access Adam's resources for Facebook.

[0023] For an embodiment, the OAuth protocol is used to facilitate the authorization procedure. The OAuth protocol is an open standard to authorization, which can be used to provide the ProSe server 118 a secured delegated access to Adam's Facebook resources, such as Adam's Facebook ID, friend list, etc., on behalf of Adam without the Facebook server 130 sharing Adam's password with the ProSe server 118. For a particular embodiment, the OAuth procedure is implemented in a manner consistent with how it is commonly used today such that changes at the Facebook server 130 and changes to APIs used by the Facebook server 130 are not required.

[0024] Namely, Adam is redirected to the Facebook application on his UE 102 to login using his Facebook

credentials. This enables Facebook authentication 214, and Adam is, therein, presented through the ProSe application with a request for permission to allow the ProSe application (or, equivalently, the ProSe server 118) to access his Facebook account and resources. Upon Adam granting this permission, the Facebook authorization procedure further includes the Facebook server 130 granting and the ProSe server 118 receiving, through messages 216, an access token to use in performing API calls on behalf of Adam. Thus, all the requests made by the ProSe server 118 to the Facebook server 130 will include the access token to enable the Facebook server 130 to authenticate and authorize the requests.

[0025] Using a message exchange 218, ProSe server 118 uses its access token to request and receive information from Adam's Facebook account, such as Adam's user ID and his friend list. Using messages 220, the ProSe server 118 communicates Adam's list of friends to him via the ProSe application on his UE 102, which is also used to communicate to the ProSe server 118 Adam's selection of which of his friends can discover him. The ProSe server 118 stores the set of selected friends for future use.

[0026] When Adam wants to start announcing his presence so that authorized Facebook friends can discover him, he initiates an announce request procedure 222 using the ProSe application on his UE 102. For example, Adam selects "Start Facebook announcements" in the ProSe application to cause his UE 102 to send a message 224 that includes a request to announce Adam's presence for discovery by his set of selected Facebook friends. The request 224, accordingly, includes Adam's Facebook ID and, in an embodiment, serves as or includes a request for a proximity-based services code. An allocated proximity-based services code is used to determine presence of Adam when a device of a second user, which has received the allocated proximity-based services code from a proximity-based services server, is in proximity to receive a broadcast of the allocated proximity-based services code by Adam's UE 102.

[0027] Upon receiving the request 224, the ProSe server 118 confirms 226 that Adam is allowed (e.g. by subscription) to perform Facebook announcements and then allocates 226 a ProSe Code for Adam for the Facebook application. For an embodiment, the ProSe code is a random or pseudo-random number or sequence of digits with sufficient length. The ProSe code may also include the identity of the PLMN that allocated this ProSe code. Moreover, the ProSe code is allocated with an associated validity duration, for example one day. The ProSe server 118 sends an announce response message 228 to Adam's UE 102. The response message 228 includes the allocated ProSe code and associated validity time.

[0028] The ProSe server 118 also announces, using a message 230 to a set of other ProSe servers (in this case ProSe servers 128 and 206), existence of the ProSe code allocated to Adam for Facebook. For a particular example, the ProSe servers 118, 128, and 206 have joined a

multicast group that has an associated multicast address for exchanging secure communications. Accordingly, announcing the ProSe code allocated to Adam for Facebook includes the ProSe server 118 multicasting 230 an announce notification to the other ProSe servers 128 and 206 in multicast group. The announce notification message 230 includes an ID for the Facebook application and a user ID, e.g., a Facebook ID for Adam, to inform all other ProSe servers that monitor the multicast address that ProSe server 118 holds the ProSe code for user Adam for Facebook.

[0029] After receiving the allocating ProSe code sent by the ProSe server 118 using the message 228, Adam's UE 102 starts announcing or broadcasting 232 this allocated code to indicate Adam's presence. Such announcing can be locally performed in the clear using technology such as LTE-direct, WiFi-direct, or BLE, for example. Moreover, for this scenario, the allocated ProSe code can be broadcast until its validity time expires, wherein the announce request procedure 222 must be re-executed for the ProSe server 118 to allocate a new ProSe code for Adam for Facebook. Those UEs in close proximity to Adam's UE 102 can receive the ProSe code broadcast by UE 102, but won't be able to associate it with an application and a user unless the UE already possesses the ProSe code for comparison, which is explained by reference to FIG. 3. For another embodiment, Adam's UE 102 locally broadcasts multiple ProSe codes for multiple applications, e.g. one for Facebook, one for Twitter, one for Google+, etc.

[0030] When a user on Adam's list of selected friends wants to discover Adam, e.g., a discovering user, the discovering user's device and a ProSe server in the discovering user's cellular network perform authentication and security establishment in a manner similar to that performed by ProSe server 118 and Adam's UE 102 using the messages 208. Additionally, the discovering user's device, the ProSe server in the discovering user's cellular network, and the Facebook server 130 exchange messages (similar to the messages 210 exchanged between UE 102, ProSe server 118, and Facebook server 130) to activate proximity-based services for the discovering user for Facebook.

[0031] For example, where George is the discovering user, George opens the ProSe application on his UE 104 to initiate an exchange of messages 302 to establish a secure connection between his UE 104 and the ProSe server 128, to enable the ProSe server 128 to authenticate George. George's UE 104, the ProSe server 128, and the Facebook server 130 exchange messages 304 in response to George's input through his ProSe application, to activate proximity-based services for George for Facebook, including the ProSe server 128 obtaining authorization to access George's resources for the Facebook application. For a particular embodiment, the ProSe server 128 obtaining authorization to access George's resources for Facebook includes using the OAuth protocol to receive an access token from the Fa-

cebook server 130 to use in performing application program interface calls to the Facebook server on behalf of George.

[0032] Namely, the ProSe application on George's UE 104 presents George with a list of applications, e.g. Facebook, Twitter, Google+, etc. To discover Facebook friends (like Adam) in close proximity, George selects Facebook from the list of applications. The cellular operator in PLMN B 120 may charge George for this type of service provision. George is then redirected to his Facebook application and is prompted to login with his Facebook credentials. After successful login, George is prompted to authorize the ProSe application (or, equivalently, the ProSe server 128), to access certain resources from his Facebook account. An example message presented can be similar to the following: "AT&T Proximity Service wants to access your public profile and friends list". George clicking OK essentially authorizes the ProSe server 128 to access certain resources from George's Facebook profile.

[0033] Using a message sequence 306 which includes the access token, the ProSe server 128 obtains a list of George's Facebook friends from the Facebook server 130. The ProSe server 128 can use George's list of friends to confirm a friend that George wants to discover (described later in more detail). The ProSe server 128 can also present George's list of friends to George, through the ProSe application on his UE 104, from which George can select those friends who can discover him.

[0034] For George to monitor for the presence of Adam, his UE 104 must receive the ProSe code allocated to Adam for Facebook. For this purpose, a monitor request procedure 308 is performed between George's UE 104, the ProSe server 128, and the ProSe server 118. More particularly, George can select an option in his ProSe application to cause his UE 104 to send a monitor request message 310 to the ProSe server 128 to receive the ProSe Code of Adam for Facebook in order to monitor for the presence of Adam. For an embodiment, the monitor request 310 includes the Facebook application ID and Adam's user ID.

[0035] The ProSe server 128 determines, at 312, whether to request Adam's Facebook ProSe code. For example, this includes the ProSe server 128 accessing George's list of Facebook friends to confirm that Adam is in George list of Facebook friends. Upon confirmation, the ProSe server 128 determines, using information received in the multicast message 230, that ProSe server 118 possesses the ProSe code allocated to Adam for Facebook. Correspondingly, ProSe server 128 sends a message 314 to the ProSe server 118 to request the ProSe Code for Adam for Facebook. The request message 314 indicates George's Facebook ID as the requesting user and Adam's Facebook ID as the monitored user.

[0036] ProSe server 118 determines, at 316, whether to communicate Adam's ProSe code for Facebook to the ProSe server 128. For example, the ProSe server 118

compares George (through his user ID) to the list of Adam's Facebook friends authorized or permitted to discover Adam. If George is on the list, the ProSe server 118 sends a response message 318 to the ProSe server 128, which includes the ProSe code for Adam for Facebook and the associated validity time, and may also include Adam's Facebook ID. The ProSe server 128 can now send a message 320 responding to the message 310 to monitor for the presence of Adam. For an embodiment, the response message 320 includes the application ID for Facebook, Adam's Facebook ID, Adam's ProSe code for Facebook, and the associated validity time.

[0037] George's UE 104 can now monitor 322 for the presence of Adam, for instance over local radio resources over which ProSe announcements are broadcast. For one example, George's UE 104 runs discovery procedures in the background, which can be based on WiFi-Direct, BLE, LTE-Direct, etc. When George's UE 104 is close enough to receive the announcements from Adam's UE 102 of Adam's ProSe code for Facebook, UE 104 can associate the ProSe code to Adam. UE 104 can, thereby, detect Adam's presence and discover Adam because UE 104 has previously stored thereon Adam's ProSe code that it received from ProSe server 128. George's UE 104 alerts George that his Facebook friend Adam is nearby, for example by using a pop-up notification. George's UE 104 can further prompt George to take certain actions, e.g. establish a Facebook chat in direct mode (from device to device), exchange photos in direct mode, etc.

[0038] For another embodiment where Adam and George are, for instance, subscribers to cellular services in the same PLMN A 110, George's UE 104 could alternatively request and receive Adam's ProSe code for Facebook from ProSe server 118 to use in discovering Adam. Conversely, if George is not a Facebook friend of Adam or if George is a Facebook friend of Adam but is not in the list friends who can discover Adam, UE 104 will not be able to retrieve Adam's Facebook ProSe code. UE 104 will, therefore, not be able to associate the broadcasted ProSe code with Adam to detect Adam's presence.

[0039] FIG. 4 shows a block diagram illustrating example internal hardware components of a user device 400, for example user devices 102 and 104 as illustrated in FIG. 1, which can be configured to facilitate implementation of embodiments according to the present teachings. "Adapted," "operative," "capable" or "configured," as used herein, means that the indicated device or components are implemented using one or more hardware elements, which may or may not be programmed with software and/or firmware as the means for the indicated components to implement their desired functionality. For a particular embodiment, the device 400 is a wireless communication device, which can be representative of a variety of mobile devices or user equipment including, for example, cellular telephones, personal digital assistants (PDAs), smart phones, laptop computers, tablets,

phablets, or other handheld or portable electronic devices. Alternatively, the device 400 is a "fixed" computing device such as a desktop computer.

[0040] As shown in FIG. 4, the internal hardware elements or components of the user device 400 include at least one of each of a processor 402, an input component 404, a communication interface 406, a memory component 408, an output component 410, and optionally a set of sensors 412, for instance where device 400 is a portable device. As further illustrated, the internal components of the device 400 are operatively coupled to one another, and in communication with one another, by way of one or more internal communication links 414, for instance an internal bus. A limited number of device components 402, 404, 406, 408, 410, 412, and 414 are shown for ease of illustration, but other embodiments may include a lesser or greater number of such components in the device 400. Moreover, other well-known elements needed for a commercial embodiment of the device 400 may be omitted from FIG. 4 for brevity.

[0041] We now turn to a brief description of the components within the schematic diagram 400. The communication interface 406 allows for communication between the user device 400 and other electronic devices, such as a ProSe server or another user device. For one embodiment, the communication interface 406 includes one or more wireless transceivers such as a cellular transceiver, a WLAN transceiver, and a Global Positioning System (GPS) transceiver. More particularly, the cellular transceiver is configured to implement any suitable cellular or cellular-based technology to conduct cellular communications of data over a cellular network, such as the cellular networks 112 and 122 of FIG. 1. The WLAN transceiver can be a WiFi transceiver configured to conduct WiFi communications over a WiFi network, in accordance with the IEEE 802.11 (a, b, g, n or ac) standard. The communication interface 406 can also include one or more wireless transceivers configured to implement peer-to-peer communications using technology such as LTE direct, BLE, etc. Where, for instance, the device 400 is a fixed device, the communication interface 406 can include a wired communication interface used to communicate through a cable modem or a digital subscriber line (DSL).

[0042] The processor 402 includes arithmetic logic and registers necessary to perform the digital processing required by the device 400 to, for example, announce or monitor the presence of an application user in a manner consistent with the embodiments described herein. For one embodiment, the processor 402 represents a primary microprocessor or central processing unit (CPU) of the device 400 such as an application processor of a smartphone. In another embodiment, the processor 402 represents a baseband processor or other ancillary or standalone processor to the CPU that is used by one or more wireless transceivers. Depending, at least in part, on the particular function being performed and a given device 400 design, various functionality or protocols may be ex-

ecuted by the processor 400 in hardware or as software or firmware code.

[0043] For one example, the processor 402 implements a protocol stack or protocol suite having multiple "layers" that each have, include, contain, or implement one or more protocols, procedures, and/or algorithms that enable various functionality of the device 400. One such layer is an application layer that contains or implements various applications installed on the device 400 including, but not limited to, a social networking application, an Internet Protocol multimedia subsystem (IMS)-based application that supports voice or video over IP, file sharing, an application that communicates with a ProSe server, etc.

[0044] For an embodiment, the input component 404 includes: one or more visual input components such as a camera lens and photosensor; one or more acoustic receiver or audio input components such as one or more transducers (e.g., microphones); and one or more mechanical input components such as a touchscreen display, a flip sensor, keyboard, keypad selection button, and/or switch. Moreover, the output component 410 can include: one or more visual output components such as a liquid crystal display and/or light emitting diode indicator; one or more audio output components such as a speaker, alarm, and/or buzzer; and one or more mechanical output components such as a vibrating mechanism. The sensors 412 can be arranged with a sensor hub to manage one or more functions of the sensors. Example sensors 412 include, but are not limited to, proximity sensors (e.g., a light detecting sensor, an ultrasound transceiver or an infrared transceiver), touch sensors, altitude sensors, an accelerometer, a tilt sensor, and a gyroscope, to name a few.

[0045] The memory component 408 represents one or more memory elements of any of a variety of forms, for example read-only memory, random access memory, static random access memory, dynamic random access memory, etc. In an embodiment, the processor 402 uses the memory component 408 to store and retrieve data. In some embodiments, the memory component 408 is integrated with the processor 402 into a single component such as on an integrated circuit. However, such a single component still usually has distinct portions/sections that perform the different processing and memory functions. The data that is stored by the memory component 408 includes, but need not be limited to, operating systems, programs (e.g., applications, protocols, and other code), and informational data.

[0046] Configuring the user device 400 and one or more of the components therein can provide a user experience as described above by reference to functionality 208, 212, 220, 224, 228, and 232 of FIG. 2 for an application user to announce his presence for restricted discovery by selected other users. Configuring the user device 400 and one or more of the components therein can further provide a user experience as relates to monitoring to detect an application user that has authorized selected

other users to discover his presence, for instance by reference to functionality 302, 304, 310, 320, and 322 of FIG. 3.

[0047] FIG. 5 shows a block diagram illustrating example internal hardware components of a ProSe server 500, for example ProSe servers 118 and 128 as illustrated in FIG. 1. As shown in FIG. 5, the internal hardware elements or components of the ProSe server 500 include at least one of each of a processor 502, a communication interface 504, and a memory component 506. As further illustrated, the internal components of the ProSe server 500 are operatively coupled to one another, and in communication with one another, by way of one or more internal communication links 508, for instance an internal bus. A limited number of device components 502, 504, 506, and 508 are shown for ease of illustration, but other embodiments may include a lesser or greater number of such components in the ProSe server 500. Moreover, other well-known elements needed for a commercial embodiment of the ProSe server 500 may be omitted from FIG. 5 for brevity.

[0048] In general, at a hardware level, the device components 502, 504, 506, and 508 function as described for the analogous device components 402, 406, 408, and 414, respectively, shown in FIG. 4. However, one or more of the device components 502, 504, 506, or 508 may have some additional features. The communication interface 504, for example, might support more simultaneous connections than the communication interface 406, and the processor 502 might be configured for a greater computational load as compared to the processor 402. Nonetheless, the ProSe server 500 is configurable through one or more of its device components 502, 504, 506, and 508 to operate, for instance, as a first or second proximity-based services server in accordance with the embodiments described above by reference to the message sequence diagrams 200 and 300 illustrated respectively in FIG. 2 and FIG. 3.

[0049] For example, for a particular embodiment, the ProSe server 500 is configured, e.g., through the cooperative operation of the processor 502 and the communication interface 504, to operate as a first proximity-based services server. The first proximity-based services server performs a method that includes obtaining authorization (e.g., 214) to access a first user's resources for a first application. The method also includes communicating (e.g., 220) a list of associates from the first user's resources and receiving (e.g., 220) an indication of a set of associates selected from the list of associates. Each associate in the set is permitted to discover the first user. The method further includes receiving a request (e.g., 224) for a proximity-based services code and allocating (e.g., 226) a first proximity-based services code to the first user for the first application. Additionally, the method includes announcing (e.g., 230), to a set of other proximity-based services servers, existence of the first proximity-based services code allocated to the first user for the first application.

[0050] As described above, the first proximity-based services server communicates (e.g., 228) the first proximity-based services code to a device of the first user. Moreover, for an embodiment, the first proximity-based services server confirms authorization (e.g., 208, 212) of the first user for proximity-based services for the first application prior to allocating the first proximity-based services code, announcing the existence of the first proximity-based services code to the set of other proximity-based services servers, and communicating the first proximity-based services code to the device of the first user. For a further embodiment, communicating the list of associates from the first user's resources and receiving the indication of a set of associates permitted to discover the first user is facilitated, at the application layer, using a proximity-based services application.

[0051] For another embodiment, the ProSe server 500 is configured, e.g., through the cooperative operation of the processor 502 and the communication interface 504, to operate as a second proximity-based services server of the set of other proximity-based services servers. The second proximity-based services server performs a method that includes receiving (e.g., 230), from the first proximity-based services server, an indication of existence of the first proximity-based services code allocated to the first user for the first application. The method further includes requesting (e.g., 314), from the first proximity-based services server, the first proximity-based services code for providing to a second user that is an associate of the first user for the first application. The second proximity-based services server responsively receives (e.g., 318) the first proximity-based services code from the first proximity-based services server.

[0052] In accordance with yet another embodiment, the ProSe server 500 is configured, e.g., through the cooperative operation of the processor 502 and the communication interface 504, to operate as the second proximity-based services server to receive (e.g., 230), from a first proximity-based services server, a first message that indicates existence of a first proximity-based services code allocated to a first user for a social networking application. The second proximity-based services server is further configured to receive authorization (e.g., 304) to access a second user's resources for the social networking application and receive (e.g., 310), from a device of the second user, a request to monitor for presence of the first user. Furthermore, the second proximity-based services server is configured to determine (e.g., 312) whether to request, from the first proximity-based services server, the first proximity-based services code for determining when the first user is in proximity to the second user.

[0053] Furthermore, the processor 502 of the second proximity-based services server can be configured to determine (e.g., 312) whether to request the first proximity-based services code by being configured to: determine whether the first user is included in a list of friends from the second user's resources for the social networking

application; and request the first proximity-based services code when the first user is included in the list of friends from the second user's resources. Additionally, the processor 502, of both the first and second ProSe servers, can be configured to join a multicast group to communicate (e.g., send and receive) the first message (e.g., 230), which indicates the existence of the first proximity-based services code allocated to the first user for the social networking application. Moreover, the processor 502 and communication interface 504 can be cooperatively configured to communicate (e.g., 320) the first proximity-based services code to the device of the second user for use in detecting presence of the first user when the second user is permitted to discover the second user.

[0054] In the foregoing specification, specific embodiments have been described. However, one of ordinary skill in the art appreciates that various modifications and changes can be made without departing from the scope of the disclosure as set forth in the claims below. Accordingly, the specification and figures are to be regarded in an illustrative rather than a restrictive sense, and all such modifications are intended to be included within the scope of present teachings.

[0055] The benefits, advantages, solutions to problems, and any element(s) that may cause any benefit, advantage, or solution to occur or become more pronounced are not to be construed as a critical, required, or essential features or elements of any or all the claims. The invention is defined solely by the appended claims including any amendments made during the pendency of this application and all equivalents of those claims as issued.

[0056] Moreover in this document, relational terms such as first and second, top and bottom, and the like may be used solely to distinguish one entity or action from another entity or action without necessarily requiring or implying any actual such relationship or order between such entities or actions. The terms "comprises," "comprising," "has," "having," "includes," "including," "contains," "containing" or any other variation thereof, are intended to cover a non-exclusive inclusion, such that a process, method, article, or apparatus that comprises, has, includes, contains a list of elements does not include only those elements but may include other elements not expressly listed or inherent to such process, method, article, or apparatus. An element preceded by "comprises ...a", "has ...a", "includes ...a", "contains ...a" does not, without more constraints, preclude the existence of additional identical elements in the process, method, article, or apparatus that comprises, has, includes, contains the element. The terms "a" and "an" are defined as one or more unless explicitly stated otherwise herein. The terms "substantially", "essentially", "approximately", "about" or any other version thereof, are defined as being close to as understood by one of ordinary skill in the art, and in one non-limiting embodiment the term is defined to be within 10%, in another embodiment within 5%, in another embodiment within 1% and in another

embodiment within 0.5%. The term "coupled" as used herein is defined as connected, although not necessarily directly and not necessarily mechanically. A device or structure that is "configured" in a certain way is configured in at least that way, but may also be configured in ways that are not listed.

[0057] It will be appreciated that some embodiments may be comprised of one or more generic or specialized processors (or "processing devices") such as microprocessors, digital signal processors, customized processors and field programmable gate arrays (FPGAs) and unique stored program instructions (including both software and firmware) that control the one or more processors to implement, in conjunction with certain non-processor circuits, some, most, or all of the functions of the method and/or apparatus described herein. Alternatively, some or all functions could be implemented by a state machine that has no stored program instructions, or in one or more application specific integrated circuits (ASICs), in which each function or some combinations of certain of the functions are implemented as custom logic. Of course, a combination of the two approaches could be used. Both the state machine and ASIC are considered herein as a "processing device" for purposes of the foregoing discussion and claim language.

[0058] Moreover, an embodiment can be implemented as a computer-readable storage medium having computer readable code stored thereon for programming a computer (e.g., comprising a processor) to perform a method as described and claimed herein. Examples of such computer-readable storage mediums include, but are not limited to, a hard disk, a CD-ROM, an optical storage device, a magnetic storage device, a ROM (Read Only Memory), a PROM (Programmable Read Only Memory), an EPROM (Erasable Programmable Read Only Memory), an EEPROM (Electrically Erasable Programmable Read Only Memory) and a Flash memory. Further, it is expected that one of ordinary skill, notwithstanding possibly significant effort and many design choices motivated by, for example, available time, current technology, and economic considerations, when guided by the concepts and principles disclosed herein will be readily capable of generating such software instructions and programs and ICs with minimal experimentation.

[0059] The Abstract of the Disclosure is provided to allow the reader to quickly ascertain the nature of the technical disclosure. It is submitted with the understanding that it will not be used to interpret or limit the scope or meaning of the claims. In addition, in the foregoing Detailed Description, it can be seen that various features are grouped together in various embodiments for the purpose of streamlining the disclosure. This method of disclosure is not to be interpreted as reflecting an intention that the claimed embodiments require more features than are expressly recited in each claim. Rather, as the following claims reflect, inventive subject matter lies in less than all features of a single disclosed embodiment. Thus the following claims are hereby incorporated into the De-

tailed Description, with each claim standing on its own as a separately claimed subject matter.

[0060] Further aspects of the invention are provided by the following numbered clauses:

1. A method for facilitating restricted discovery of a user of an application, the method comprising a first proximity-based services server performing:

obtaining authorization to access a first user's resources for a first application;

communicating a list of associates from the first user's resources;

receiving an indication of a set of associates selected from the list of associates, wherein each associate in the set is permitted to discover the first user;

receiving a request for a proximity-based services code;

allocating a first proximity-based services code to the first user for the first application;

announcing, to a set of other proximity-based services servers, existence of the first proximity-based services code allocated to the first user for the first application.

2. The method of clause 1 further comprising the first proximity-based services server communicating the first proximity-based services code to a device of the first user.

3. The method of clause 2 further comprising the first proximity-based services server confirming authorization of the first user for proximity-based services for the first application prior to allocating the first proximity-based services code, announcing the existence of the first proximity-based services code to the set of other proximity-based services servers, and communicating the first proximity-based services code to the device of the first user.

4. The method of clause 2 further comprising the first proximity-based services server performing:

receiving, from a second proximity-based services server of the set of other proximity-based services servers, a request for the first proximity-based services code allocated for the first user; and

determining whether to communicate the first proximity-based services code to the second proximity-based services server.

5. The method of clause 4, wherein the request for the first proximity-based services code indicates a second user of the first application, wherein determining whether to communicate the first proximity-based services code to the second proximity-based services server comprises the first proximity-based services server performing:

comparing the second user to the set of associates permitted to discover the first user; communicating the first proximity-based services code to the second proximity-based services server when the second user is within the set of associates permitted to discover the first user.

6. The method of clause 1, wherein the first proximity-based services code is used to determine presence of the first user when a device of the second user, which has received the first proximity-based services code from a proximity-based services server, is in proximity to receive a broadcast of the first proximity-based services code by the device of the first user.

7. The method of clause 1, wherein communicating the list of associates from the first user's resources and receiving the indication of a set of associates permitted to discover the first user is facilitated using a proximity-based services application.

8. The method of clause 1, wherein announcing the first proximity-based services code comprises multicasting the first proximity-based services code to a group that includes the set of other proximity-based services servers.

9. The method of clause 1, wherein obtaining authorization to access the first user's resources for the first application comprises receiving an access token from an application server hosting the first application to use in performing application program interface calls to the application server on behalf of the first user.

10. The method of clause 9, wherein authorization to access the first user's resources is obtained using OAuth protocol.

11. The method of clause 1, wherein communicating the list of associates from the first user's resources comprises communicating a list of friends from the first user's resources for a social networking application.

12. A method for facilitating restricted discovery of a user of an application, the method comprising a second proximity-based services server performing:

receiving, from a first proximity-based services

server, an indication of existence of a first proximity-based services code allocated to a first user for a first application;

requesting, from the first proximity-based services server, the first proximity-based services code for providing to a second user that is an associate of the first user for the first application;

receiving the first proximity-based services code from the first proximity-based services server.

13. The method of clause 12, wherein the first proximity-based services code is received when the second user is on a list of users permitted to discover the first user.

14. The method of clause 12 further comprising the second proximity-based services server performing:

obtaining authorization to access the second user's resources for the first application;
receiving, from a device of the second user, a request to monitor for presence of the first user;
determining whether to request the first proximity-based services code from the first proximity-based services server.

15. The method of clause 14, wherein determining whether to request the first proximity-based services code from the first proximity-based services server comprises the second proximity-based services server performing:

accessing a list of associates from the second user's resources for the first application;
requesting the first proximity-based services code when the first user is included in the list of associates from the second user's resources.

16. The method of clause 14, wherein obtaining authorization to access the second user's resources for the first application comprises receiving an access token from a social networking server hosting the first application to use in performing application program interface calls to the social networking server on behalf of the second user.

17. A second proximity-based services server configured for facilitating restricted discovery of a user of an application, the second proximity-based services server comprising:
a processor and communication interface operatively coupled and configured to:

receive, from a first proximity-based services server, a first message that indicates existence of a first proximity-based services code allocated

to a first user for a social networking application;

receive authorization to access a second user's resources for the social networking application;
receive, from a device of the second user, a request to monitor for presence of the first user;
determine whether to request, from the first proximity-based services server, the first proximity-based services code for determining when the first user is in proximity to the second user.

18. The second proximity-based services server of clause 16, wherein the processor is configured to determine whether to request the first proximity-based services code by being configured to:

determine whether the first user is included in a list of friends from the second user's resources for the social networking application;
request the first proximity-based services code when the first user is included in the list of friends from the second user's resources.

19. The second proximity-based services server of clause 18, wherein the processor is configured to join a multicast group to receive the first message.

20. The second proximity-based services server of clause 16, wherein the processor and communication interface are cooperatively configured to communicate the first proximity-based services code to a device of the second user for use in detecting presence of the first user when the second user is permitted to discover the second user.

Claims

1. A first user equipment (102) for facilitating restricted discovery of a first user of an application, the first user equipment (102) comprising:

a processor (402) and communication interface (406) operatively coupled and configured to:
execute (208, 210) a message exchange with a first proximity-based services server (118) and an application server (130) providing the application to activate proximity services supplied to the first user, the message exchange providing authorization for the first proximity-based services server (118) to access the first user's resources for the application,
wherein the first user equipment is **characterized in that** the processor (402) and communication interface (406) are configured to:

receive (220) a list of associates from the first user's resources;

- obtain an indication of a set of associates selected from the list of associates, wherein each associate in the set is permitted to discover the first user;
 send (220) the indication of the set of associates to the first proximity-based services server (118);
 initiate (222) an announce request procedure with the first proximity-based services server (118);
 receive (228) a first proximity-based services code allocated for the first user from the first proximity-based services server (118);
 and
 broadcast (232) the first proximity-based services code,
- wherein the first user is discoverable by a second user equipment (104) associated with a second user of the application that has access to the first proximity-based services code and that receives the broadcast from the first user equipment (102), the second user equipment (104) having access to the first proximity-based services code responsive to a determination by the first proximity-based services server (118) that the second user is within the set of associates permitted to discover the first user.
2. The first user equipment (102) of claim 1, wherein the processor (402) and communication interface (406) are configured to:
 - execute (208) a message exchange with the first proximity-based services server (118) to authenticate the first user; and
 - execute (210) a message exchange with the first proximity-based services server (118) and the application server (130) to activate proximity services supplied to the first user.
 3. The first user equipment (102) of claim 1 or claim 2, wherein the communication interface (406) comprises one or more wireless transceivers to implement peer-to-peer communications, and wherein the first proximity-based services code is broadcast using said one or more wireless transceivers.
 4. The first user equipment (102) of any one of claims 1 to 3, where the message exchange uses an OAuth protocol.
 5. The first user equipment (102) of any one of claims 1 to 4, wherein the processor (402) and communication interface (406) are configured to initiate the announce request procedure by sending a request to announce the presence of the first user for discovery by the set of associates to the first proximity-based services server (118), the request comprising an identifier for the application.
 6. The first user equipment (102) of claim 5, wherein the request to announce the presence of the first user for discovery comprises a validity duration for the first proximity-based services code.
 7. The first user equipment (102) of any one of claims 1 to 6, wherein the processor (402) and communication interface (406) are configured to broadcast (232) a proximity-based services code for a further application.
 8. A second user equipment (104) for facilitating restricted discovery of a first user of an application, the second user equipment (104) comprising:
 - a processor (402) and communication interface (406) operatively coupled and configured to: execute (302, 304) a message exchange with a second proximity-based services server (128) and an application server (130) providing the application to activate proximity services supplied to a second user, the message exchange providing authorization for the second proximity-based services server (128) to access the second user's resources for the application, wherein the second user equipment is **characterized in that** the processor (402) and communication interface (406) are configured to:
 - send (310) a request for a first proximity-based services code associated with restricted discovery of the first user to the second proximity-based services server (128); responsive to a determination by the second proximity-based services server (128) indicating that the first user is included in a list of associates from the second user's resources, receive (320) the first proximity-based services code from the second proximity-based services server (128); responsive to receipt of the first proximity-based services code, monitor for a broadcast from a first user equipment (102) associated with the first user; responsive to detection of a broadcast from the first user equipment (102), determine (322) whether the broadcast comprises the first proximity-based services code; and responsive to the broadcast comprising the first proximity-based services code, indicate (322) to the second user that the first user is nearby.
 9. The second user equipment (104) of claim 8, wherein the first proximity-based services code is retrieved

by the second proximity-based services server (128) from a first proximity-based services server (118) responsive to the determination by the second proximity-based services server.

10. The second user equipment (104) of claim 8, wherein the second proximity-based services server (128) comprises a first proximity-based services server (118) configured to provide proximity services to the first user.

11. The second user equipment (104) of any one of claims 8 to 10, wherein the processor (402) and communication interface (406) are configured to:

receive a list of associates from the second user's resources; and
obtain an indication of a set of associates selected from the list of associates, wherein each associate in the set is permitted to discover the second user,
wherein the request for a first proximity-based services code is sent responsive to the first user being within the set of associates.

12. A method for facilitating restricted discovery of a first user of an application, the method comprising a first user equipment performing:

exchange messages with a first proximity-based services server (128) and an application server (130) providing the application to activate proximity services supplied to the first user, the exchange of messages providing authorization for the first proximity-based services server (128) to access the first user's resources for the application,
wherein the method is **characterised by** the first user equipment performing:

receiving (220) a list of associates from the first user's resources;
obtaining an indication of a set of associates selected from the list of associates, wherein each associate in the set is permitted to discover the first user;
sending (220) the indication of the set of associates to the first proximity-based services server (118);
initiating (222) an announce request procedure with the first proximity-based services server (118);
receiving (228) a first proximity-based services code allocated for the first user from the first proximity-based services server (118); and
broadcasting (232) the first proximity-based services code, and

wherein the first user is discoverable by a second user equipment (104) associated with a second user of the application that has access to the first proximity-based services code and that receives the broadcast from the first user equipment (102), the second user equipment (104) having access to the first proximity-based services code responsive to a determination by the first proximity-based services server (118) that the second user is within the set of associates permitted to discover the first user.

13. A method for facilitating restricted discovery of a first user of an application, the method comprising a second user equipment performing:

exchanging (302, 304) messages with a second proximity-based services server (128) and an application server (130) providing the application to activate proximity services supplied to a second user, the message exchange providing authorization for the second proximity-based services server (128) to access the second user's resources for the application,
wherein the method is **characterised by** the second user equipment (104) performing:

sending (310) a request for a first proximity-based services code associated with restricted discovery of the first user to the second proximity-based services server (128);
responsive to a determination by the second proximity-based services server (128) indicating that the first user is included in a list of associates from the second user's resources, receiving (320) the first proximity-based services code from the second proximity-based services server (128);
responsive to receipt of the first proximity-based services code, monitoring for a broadcast from a first user equipment (102) associated with the first user;
responsive to detection of a broadcast from the first user equipment (102), determining (322) whether the broadcast comprises the first proximity-based services code; and
responsive to the broadcast comprising the first proximity-based services code, indicating (322) to the second user that the first user is nearby.

14. A first proximity-based services server (500) configured for facilitating restricted discovery of a user of an application, the first proximity-based services server (500) comprising:

a processor (502) and communication interface (504) operatively coupled and configured to:

receive (224) a request for a proximity-based services code;
 allocate (226) a first proximity-based services code to a first user for a first application;
 and
 announce (230), to a set of other proximity-based services servers, existence of the first proximity-based services code allocated to the first user for the first application,

wherein the first proximity-based services server (500) is **characterised in that** the processor (502) and communication interface (504) are configured to:

obtain (214) authorization to access the first user's resources for the first application;
 communicate (218) a list of associates from the first user's resources;
 receive (220) an indication of a set of associates selected from the list of associates, wherein each associate in the set is permitted to discover the first user;
 receive (314), from a second proximity-based services server of the set of other proximity-based services servers, a request for the first proximity-based services code allocated for the first user, the request indicating a second user of the first application;
 and
 determine (316) whether to communicate the first proximity-based services code to the second proximity-based services server, including to:

compare the second user to the set of associates permitted to discover the first user; and
 communicate (318) the first proximity-based services code to the second proximity-based services server when the second user is within the set of associates permitted to discover the first user.

15. A proximity-based services server (500) configured for facilitating restricted discovery of a user of an application, the proximity-based services server (500) comprising:

a processor (502) and communication interface (504) operatively coupled and configured to:

receive (224) a request for a proximity-based services code; and
 allocate (226) a first proximity-based services code to a first user for a first application;

wherein the proximity-based services server (500) is **characterised in that** the processor (502) and communication interface (504) are configured to:

receive a request for the first proximity-based services code allocated for the first user, the request indicating a second user of the application;
 determine whether the second user is within a first set of associates permitted to discover the first user and whether the first user is within a second set of associates permitted to discover the second user, the proximity-based services server (500) being authorised by the first user and the second user to access respective associate data associated with the application;
 responsive to the second user being within the first set of associates and the first user being within the second set of associates, communicating (318) the first proximity-based services code to a device of the second user for use in detecting a presence of the first user.

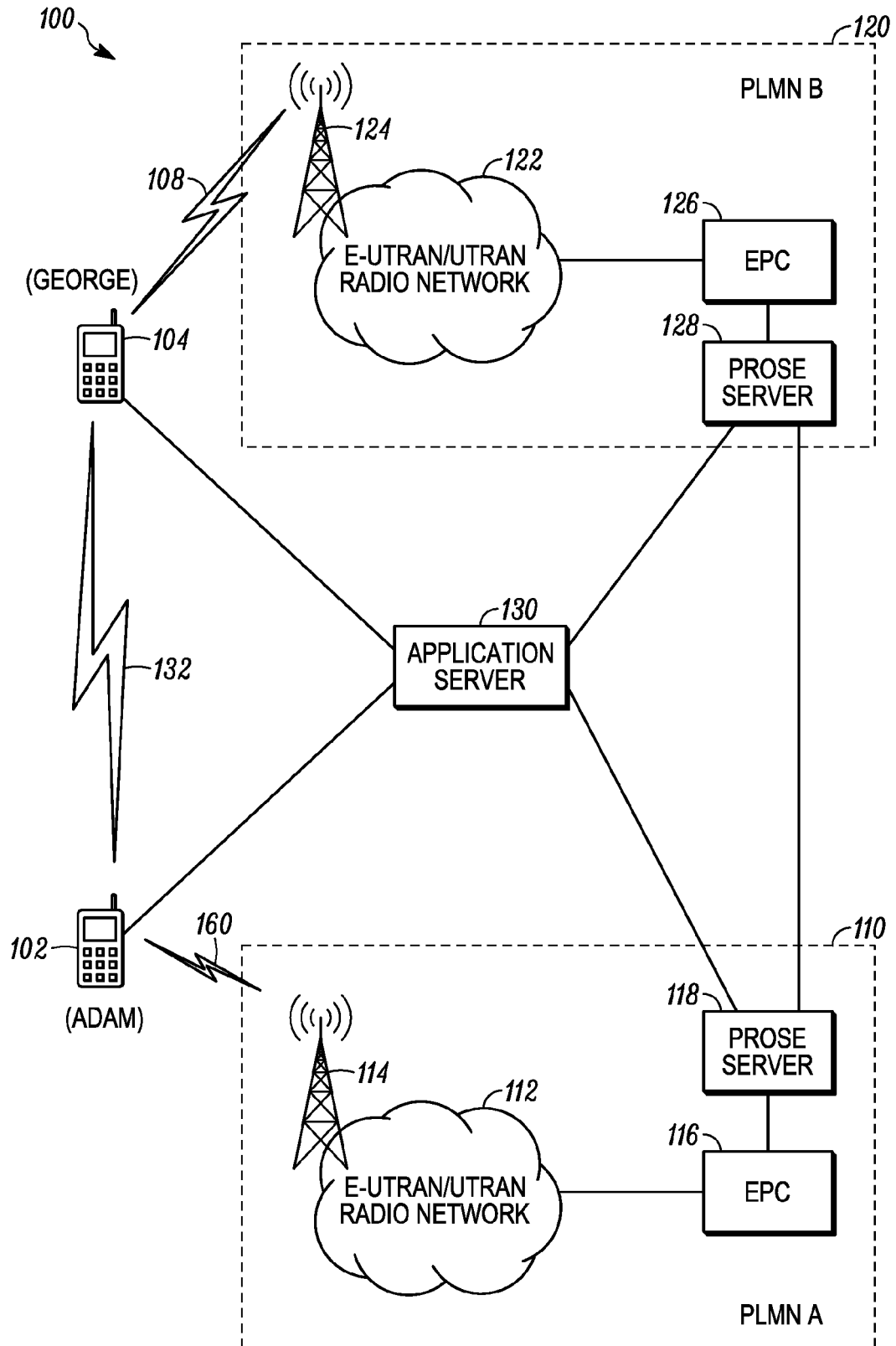


FIG. 1

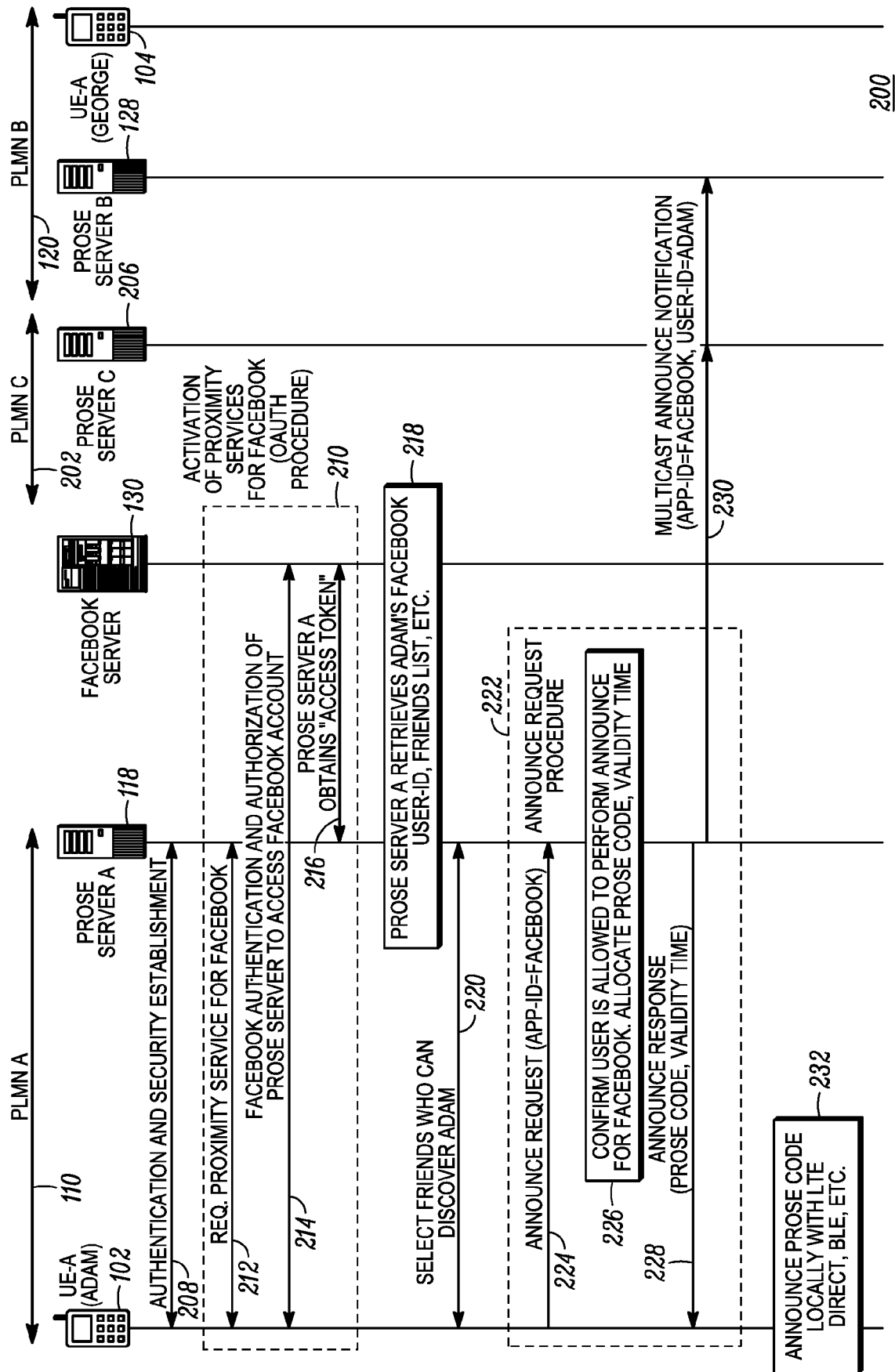


FIG. 2

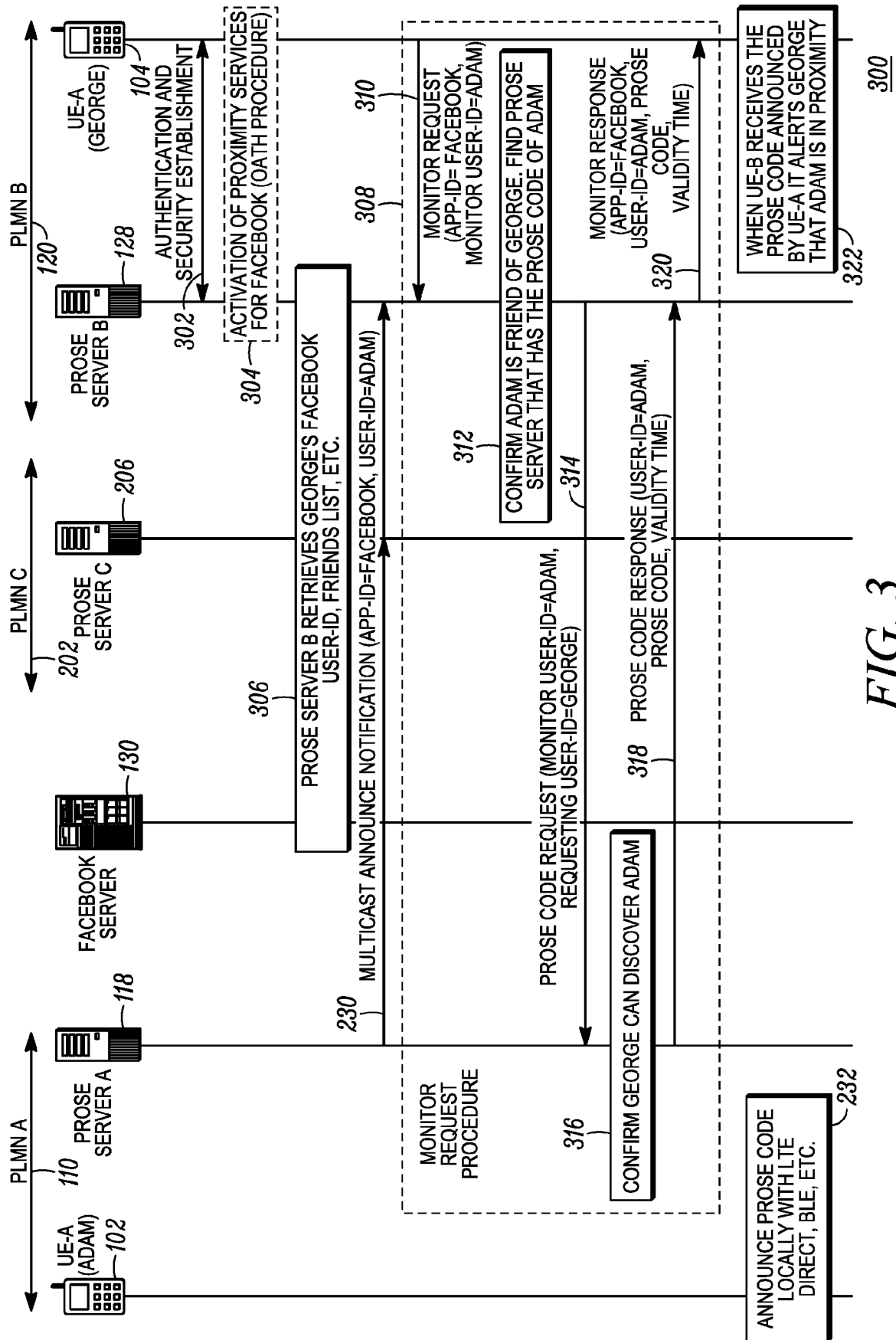


FIG. 3

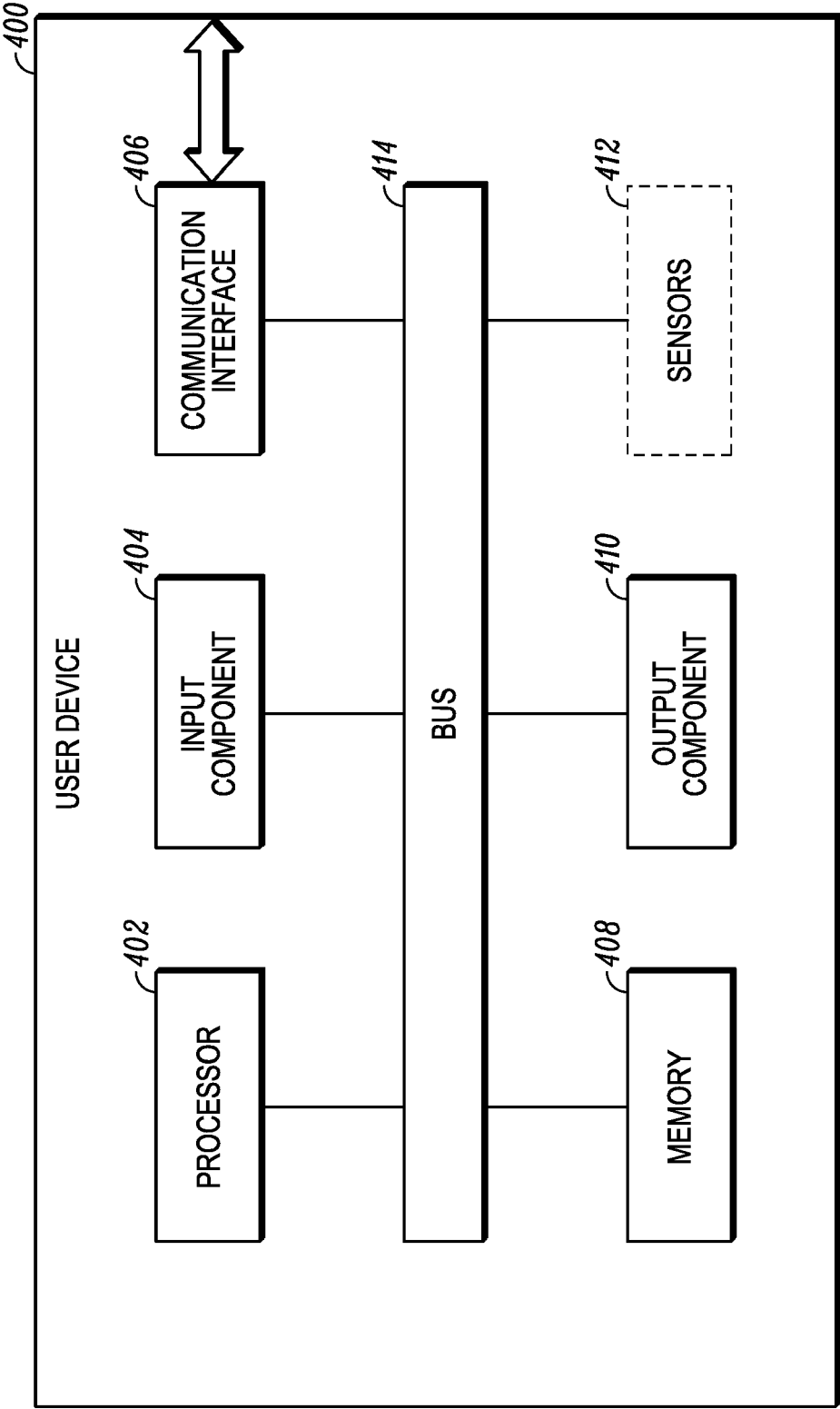


FIG. 4

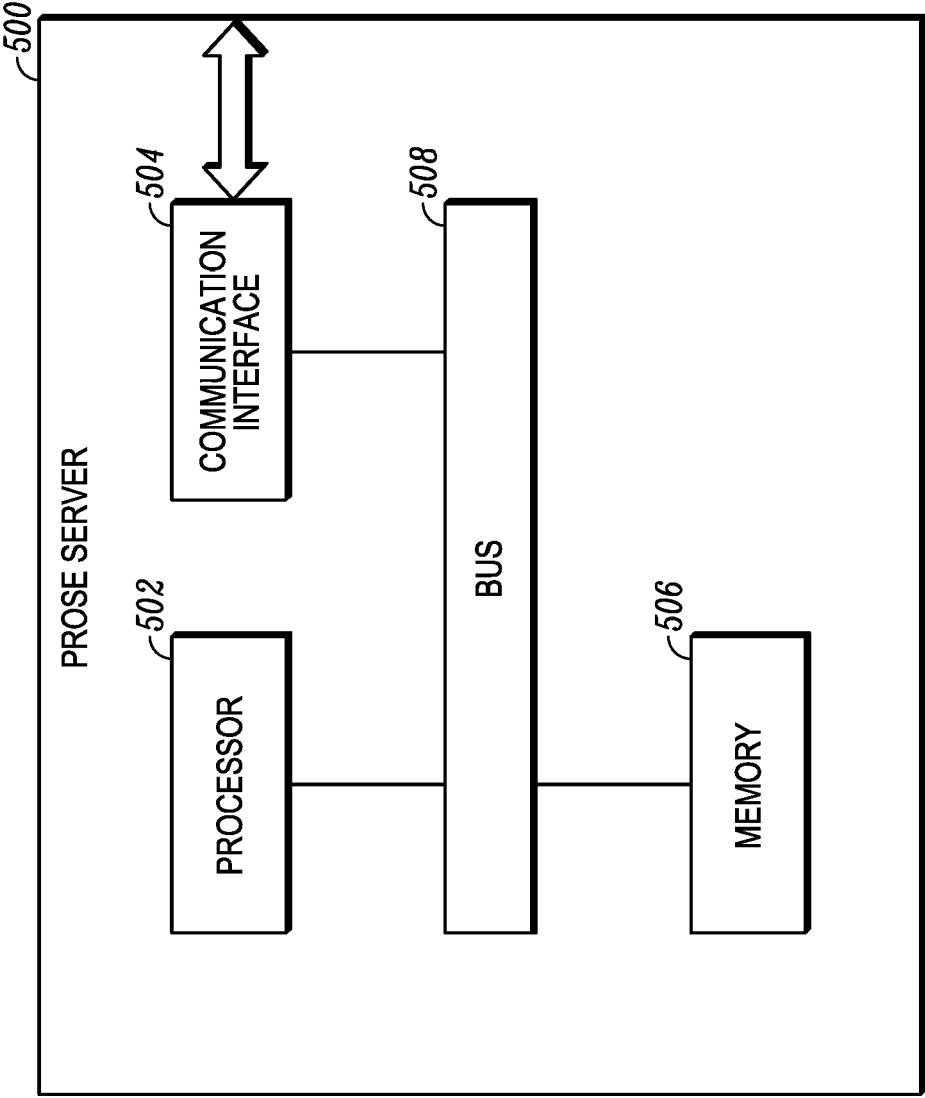


FIG. 5

REFERENCES CITED IN THE DESCRIPTION

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